

Industrial Technologies Program

Energy-Efficient Melting and Direct Delivery of High Quality Molten Aluminum

Complete Scrap-to-Caster System Will Save Energy and Cost

Most primary and secondary aluminum are melted in natural gas-fired reverberatory furnaces. The heat is transferred to the surface of the molten aluminum predominantly by refractory radiation and some convection. Since heat transfer is principally through radiation, furnaces have poor thermal efficiencies ranging from approximately 20 to 45 percent. The project, Energy Efficient Isothermal Melting (ITM) of Aluminum, developed energy-efficient and emissions-free electric melting furnaces for large-scale aluminum operations. These direct immersion electric resistance heaters yield high thermal efficiency (more than 70% overall) and low melt loss (less than 1%). The ITM project team designed, built, and operated a commercial stand-alone furnace with melt rate of 5,000 pounds per hour (lb/hr) in 2005. Upon completion of this original ITM research, the project has

been extended to further improve energy efficiency.

The extension project will develop a combined system to efficiently melt and deliver molten metal. The system involves preparing the metal at off site locations using ITM furnaces and transporting it over the road to casting operations using ITM immersion heaters in transfer vessels. Docking stations at remote casting operations receive these vessels which allow them to be drawn down over a period of time required by the casting processes, essentially displacing on site holding furnaces. These holding vessels operate at <10 Btu/hr-lb compared to 30 to 40 Btu/hr-lb used by a typical industry holding furnaces. Therefore, the combined system will outsource melting and eliminate large holding furnaces in many production facilities. Melting operations can be centrally located and operated in the most efficient mode, and foundries will receive ready-for-use and treated molten metal.



A 7,000lb commercial prototype ITM was commissioned for Aleris Rolled Products at their Newport, OH facility. This unit is capable of a 5,000lb/hr output when melting light weight scrap (edge trim), and up to 7,000lb/hr solid charge.



Benefits for Our Industry and Our Nation

- Potential energy savings of about 12.7 trillion Btu per year by 2020
- Potential cost savings of about \$45.7 million per year by 2020
- Elimination of on site generation of combustion gases, including carbon dioxide (CO₂), sulfur oxide (SO_x), nitrogen oxide (NO_x), and particulates
- Reduction of dross formation

Applications in Our Nation's Industries

The project will add significant benefit to the domestic aluminum industry in energy saving and environmental impact. The system not only applies to the aluminum industry, but other metals processing industries as well, with the potential to offer major improvements in costs, environmental impact, and energy consumption.

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Project Description

The objective of the project is to demonstrate the capability to operate one lost foam casting cell with ready-to-use metal delivered by large portable ladles from off site melting facilities. The project will integrate ITM furnaces, high heat flux trough heating system, and large portable ladles to form a complete scrap-to-caster system.

Barriers

- Developing and demonstrating an integrated system to melt and transport molten aluminum
- Creating a paradigm shift in the industry required for implementing this technology

Pathways

The objectives of this project are to

- develop electrically heated vessels to transfer molten metal to casting operations,
- develop docking stations to receive molten metal, and
- integrate the technologies with an ITM furnace to form a complete system that improves energy efficiency.

Milestones

The following are the project milestones:

- Implement stand-alone direct immersion (DI) heaters for melting, and baffle and side pocket panel (BSPP) heaters for holding
- Implement conductive trough (CT)
- Design, build, and operate 7,000 lb/hr sized ITM furnace
- Design, build, and operate heated detainable ladles, called TurboElectric Ladles (TeL), and docking stations
- Integrate ITM/TeL/CT unit operations to support 6,000 lb/hr casting line

Commercialization

The commercial applications for the integrated ITM/TeL metal supply system are widespread. In the aluminum industry, both the wrought alloy and engineered castings sectors will have a compelling need for the integrated system. This system consists of a high efficiency melter, heated metal transfer troughs, transfer ladles, and two separate heating devices of high and moderate watt densities. These stand-alone products are germane to the industry and represent significant commercial opportunities.

Project Partners

Apogee Technology, Incorporated
Verona, PA
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General Motors
Saginaw, MI

IMCO Recycling
Saginaw, MI

Commonwealth Aluminum
Uhrichsville, OH

Drexel University
Philadelphia, PA

Argonne National Laboratory
Argonne, IL

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.



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